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CONTENTS.

HEELEAKA CLEARANCE.

In the Quarterly Journal, Part II of 1911, and in the Report of the Heeleaka Experimental Station for the year 1908 information was given about a small clearance at Heeleaka which was started in order to compare the characteristics of seven different varieties of tea.

The Heeleaka Experimental Station was closed in the year 1911, and at that time this clearance was incorporated with the surrounding tea belonging to the Scottish Assam Tea Company.

It may be remembered that the nursery for this clearance was sown in 1905, and that the seven varieties of seed were Alyne, Bazalony, Jaipur, Kalline, Kokeecherra, Lushai, and Singlo. The seedlings were planted out 5 x 5 triangular in June 1906, and, with the exception of a quarter of each plot, the young plants were cut down in February 1909, the remaining quarters of each plot being cut down in May of that year.

The following quotation from the Heeleaka Experimental Station Report on investigations during 1908 indicates the condition of the different varieties of tea in 1909 :—

> "The Manipuri varieties, the Kalline, Kokeecherra, and Alyne, have so far come on as well as the lighter-leaved varieties, though the Jaipur is equally good and Bazalony is little, if at all, inferior. Singlo is uneven and Lushai is markedly inferior to any of the others : not only is the average height of the bushes very much less than the others, but the bushes suffered from the early droughts, and there is on this plot the largest number of vacancies. Evidently there is a certain class of light soils here which is not favourable to the Lushai variety of tea bush."

In the article in the Quarterly Journal above referred to it was stated that the light leaved Assam varieties suffered more from

the later pruning than the hardier Manipuri bushes, and that later on when the bushes were plucked the Manipuri varieties gave greater leaf weights than the Assam varieties, with the exception of the Jaipur tea.

These plots were visited a little while ago, and at the present time—August 1916—the bushes are unpruned, and it is very interesting to notice that the direction in which differences showed themselves early in the history of the tea have generally, though not entirely, been maintained. At the time of this recent visit the Lushai plot looked miserable and of an unhealthy yellow colour, and, although the section was about to be plucked on the day it was visited, there was no leaf on the bushes and the wood was very poor. The plot was also full of vacancies. The plots of Kalline, Alyne, and Kokeecherra were still noticeably better than the Assam varieties, the Kokeecherra being remarkable for its even appearance considering that it was unpruned. The Kalline looked in good condition but it may possibly have been favourably affected by its proximity to cooly lines. There were some vacancies in the Alyne plot, though it was generally very healthy and had more leaf on it than the others. The Singlo approximated perhaps best in general health to the Manipuri varieties, though the Bazalony also looked healthy and had fair and even growth, but curiously enough its jat appeared to have deteriorated. The Jaipur was distinctly poor and has hardly maintained its early promise.

The present manager of the Scottish Assam Tea Company is now arranging to watch these plots very closely, and, as all the plots will be treated alike, as they have been heretofore, it will be possible to report later on the behaviour of these different varieties grown under same conditions.

RESIDUAL EFFECT OF PHOSPHATIC MANURES ON GREEN CROPS IN THE YEAR FOLLOWING THAT OF APPLICATION.

In the Quarterly Journal Part IV of 1915 a preliminary note was published of the results of trials of four forms of phosphatic manures with green crops, such quantities of manure being used that 112 lbs. of phosphoric acid per acre were applied in each case.

After removing the green crop an attempt was made to measure the residual effect of the manures on seed production by resowing the same green manures early in October. On account of the drought then experienced, however, the plants made very little growth indeed, and were allowed to wither off as they stood, after collection of a very small quantity of seed.

The small remains of the crops were then hoed in.

Two good hoes were given in the spring to avoid the complication of jungle growth, and the plots were resown early in June, without further manurial treatment, in order to determine the residual value of the manures applied last year.

Of the twelve series of plots, two were still occupied, one by *Tephrosia candida*, (Boga medeloa) and the other by *Tephrosia purpurea*, planted in August 1915.

The other ten series were planted as follows :—

2 series with *Crotolaria juncea* (Sunn hemp.)
2 series with *Sesbania aculeata* (Dhaincha.)
3 series with *Vigna catiang* (Cowpeas.)
3 series with *Tephrosia candida* (Boga medeloa.)

It was considered that more trustworthy results would be obtained by averaging the results from two or more trials on the same plant than by making trials on a larger number of different plants.

The four crops chosen were those which are at present considered the most generally useful green crop plants in the plains. They are also crops which usually give fairly even growth, and are therefore suited for accurate experiment.

In addition to increases per cent. over the check plot, the actual yields in cwts. per acre are given, because it is interesting to record the comparative yields given by the various crops in the same time under the same conditions.

On account of dry weather at the end of May and in early June growth was slow, and, as it was desired to weigh the crop when approaching maturity, each crop was allowed to occupy the soil for nine weeks.

The following table shows the results obtained :—

	COWPEAS. Weight of crop in cwt. p. acre.	Incr. or Decr. %	DHAINCHA. Weight of crop in cwt. p. acre.	Incr. or Decr. %	SUNN HEMP. Weight of crop in cwt. p. acre.	Incr. or Decr. %	BOGA MEDELOA. Weight of crop in cwt. p. acre.	Incr. or Decr. %	Mean crop.	Average increase per cent.
Lime only	a 117, b 109, c 108 } 111	−13	a 67, b 64 } 65½	−17	a 23, b 37 } 30	+3	54	+8	65	−8
(*Check plot.*) Lime ... ... Sulphate of ammonia ... ... Sulphate of potash	a 131, b 123 } 127, *c (87)	...	a 86, b 72 } 79	...	a 24, b 34 } 29	...	50	...	71	...
Lime— Sulphate of ammonia ... ... Sulphate of potash ... ... EPHOS BASIC PHOSPHATE ...	a 142, b 148 } 145, °c (111)	+14	a 93, b 81 } 87	+10	a 36, b 54 } 45	+56	64	+28	85	+20
Lime— Sulphate of ammonia ... ... Sulphate of potash ... ... DEGELATINISED BONES ...	a 155, b 160, c 165 } 160	+26	a 91, b 96 } 93½	+18	a 60, b 117 } 88½	+205	71	+42·½	103	+45
Lime— Sulphate of ammonia ... ... Sulphate of potash ... ... SUPERPHOSPHATE ...	a 182, b 184, c 180 } 182	+43	a 123, b 180 } 151½	+92	a 96, b 143 } 119½	+312	86	+72	135	+90
Lime— Sulphate of ammonia ... ... Sulphate of potash ... ... BASIC SLAG	a 184, b 174, c 180 } 179	+41	a 137, b 174 } 155½	+97	a 129, b 141 } 135	+365	90	+80	140	+97
Average crop	151	...	105	...	74·5	...	68	...	...	...

* This bed was sown by error with old seed which failed to germinate. It was filled up by transplanting seedlings of the same age as the plants in the other beds, but the check to growth due to transplanting was so great that the crop results are useless for comparison.

The agreement among the parallel experiments is generally good enough to show that the variation in the soil is not sufficient to invalidate results.

The cowpea plots were eminently satisfactory in this respect, mainly because each plant in a bed resembled every other plant in the same bed ; that is all the beds were very even.

The Boga medeloa plots were also very even. Boga medeloa is not a plant recommended when a quick growing green manure is wanted ; for this reason only one series was measured at this stage while the other two were left over for measurement after a longer growing period.

Dhaincha grew very unevenly, there being on each plot very well and very badly-developed plants. This was probably due to variation in the seed ; very even plots were obtained in last year's experiments with Dhaincha. It is probably on account of this variation in seed that the agreement between the duplicate experiments is not so good, but the averages can be trusted to show with sufficient accuracy the comparative efficiency of the various manures on Dhaincha under the conditions of the experiment.

The Sunn hemp also grew unevenly. The agreement shown between the duplicates is here very bad. The plots of Sunn hemp series *a* were on a piece of land low lying and less efficiently drained than in the case of the plots of Sunn hemp series *b*, and the poorer crops are undoubtedly due to this reason. However it can be seen that the crops are consistently poorer throughout series *a* and the comparative results on this series *a* are very much the same as the comparative results on series *b*, with the exception that the basic slag plot of series *a* gives an abnormally high result, and this plot was clearly the one least affected by the inefficiency of the drainage.

The chief information gained in this year's experiments is that the various forms of phosphatic manure used are in the same order of relative efficiency in the second year as they were in the first year of application. The differences obtained with different manures, and the differences between the check plots and those which received phosphatic manures, are, however, much less marked.

The following table shows the increases due to the different phosphatic manures experimented with, averaged over all the crops used in the two years under consideration :—

	Increase over check plot	
	1915	1916
Ephos Basic Phosphate	38	20
Degelatinised Bones	164	45
Superphosphate	273	90
Basic Slag	273	97

The great superiority of superphosphate and basic slag is maintained.

It is doubtful whether the experiments are sufficiently accurate to enable us to state that the slight superiority shown by basic slag over superphosphate is to be depended on. We are of opinion that basic slag is slightly superior, but that the difference is very slight. For all practical purposes it may be taken that for equal weights of phosphoric acid these two manures are equal in effect, and that at present prices therefore superphosphate offers the best value for money.

It is necessary to repeat the warning that the *continued* use of superphosphate on account of its strong acidity is likely to do more harm than good to our acid tea soils, unless some lime is applied: but where applications of lime are occasionally given, even if they are only light, superphosphate is the form of phosphatic manure recommended at the present time for use when growing green crops.

On those few soils where the use of lime by itself is not thought to give any result, and lime therefore is never applied, it would be better to pay the extra price for basic slag, and avoid the use of superphosphate altogether.

The other two forms of phosphatic manure tried are too slow in action on this soil to be worth applying for the special purpose of growing a green crop which does not grow well unassisted.

Ephos basic phosphate has again proved disappointing. The sample used in these experiments was from the first shipment to this country and may not represent the average of this product. In any case one hesitates, on this evidence of experiments conducted on a single sample, to condemn altogether a manure which is said to have generally done well in other countries, and judgment must be reserved. It is still possible of course, that the small increase produced by this manure will extend over many years, while the effect of the more readily available manures may be expected to disappear after three or four years. This point still remains to be proved. If it is proved, then there is a use in tea cultivation for manures so slow in action as this sample of Ephos Basic Phosphate has proved to be.

It will be useful to compare the results obtained at Borbhetta with phosphatic manures with those obtained in England.

In 1904 A. D. Hall at Rothamsted started an experiment with bone meal, superphosphate, and basic slag. For each manure five plots were set aside. One of these was manured in 1904, one in 1905, one in 1906, one in 1907, while the fifth remained unmanured and served as a check. The manured plots received another dressing of the same manure four years after the previous application, because the effect of manuring appeared to have disappeared by that time.

The following results were obtained, the yield of the unmanured plot being taken as 100 :—

	Year of application Mean of 9.	1 year old *residue* Mean of 8.	2 years old *residue* Mean of 7.	3 years old *residue* Mean of 6.
Superphosphate	116·2	109·1	113·8	107·8
Bone Meal	114·6	112·4	109·1	105·6
Basic Slag	114·5	110·5	104·8	112·0

With these three manures it was found :—

(1) that phosphatic manures persist in the soil, and that the residual effect is roughly proportional to the amount of phosphate unused.

(2) that superphosphate, though soluble in water, is as lasting as bone meal and basic slag.

It will be seen from the Table that the effects of bone meal, superphosphate, and basic slag were all found roughly equal in any year.

These results were obtained on a rotation of alternating corn and roots, and on a soil differing from that at Borbhetta in many respects, but chiefly in being well supplied with lime, and not so remarkably deficient in phosphoric acid.

Very much smaller increases are therefore to be expected in the case of Hall's experiments than on the Borbhetta soil with green crops.

The Borbhetta experiments confirm the equality of basic slag and superphosphate even on our acid soils, when this soil is supplied with a very small dressing of lime which still leaves the soil markedly acid. The lime requirement for neutralization of Borbhetta soil is about two tons of quicklime per acre. Only ten maunds of crushed limestone were used in these experiments.

The bones however were not found so effective.

The form of bones used in our experiment was "Degelatinised Bones," which were delivered in big lumps and applied in that form.

The comparatively small effect may be due to their state of division, though it is true that such a point can only be determined by exact experiment. Bones have not appeared so far to be very effective as a manure for tea. This year several varieties of bone meal are being tried in conjunction with green crops.

It must be remembered that these experiments at Borbhetta have been made on green manure crops, and that the result cannot be closely applied to the direct manuring of tea. It is possible that, with a crop like tea, which remains in the soil for many years, better results over a long period may be obtained for the same expenditure by the application of forms of phosphatic manure which only slowly come into action and are therefore only slowly used.

The use of the less rapidly available forms of phosphate, however, is only justified if these forms are very much cheaper per unit of phosphoric acid.

There are now on the market various bone products at prices ranging from Rs. 60—75 as against Rs. 90—95 for superphosphate and containing slightly larger percentages of phosphoric acid.

Bones also contain about 5% of nitrogen though the value of nitrogen in this form is uncertain and is not very great.

It is sometimes possible to collect and crush bones locally at much cheaper rates than the above.

The cheaper forms of bone, therefore, are well worth experiment, and trials with them are now being conducted on green crops by this department. It is unfortunate that we have as yet no plot of tea for such purposes, but green crops offer a ready means of determining availability, and the results will be of some value.

The sellers of certain of these bone products recommend that, before use, the manure should be stacked in heaps for some time and watered at intervals. This treatment would undoubtedly increase the value of the manure, but it would be still more effective if the heaps were not of bones alone, but of bones mixed with green vegetable matter. The phosphates of the bones by this treatment would be rendered much more readily available, and such a mixture of fermented bones and vegetable matter would be an extremely valuable manure, well worth a trial on tea.

In the following table are shown results on Boga medeloa at three different stages of growth. We have no measurements of this crop after six weeks from a sowing immediately following an application of phosphatic manure, but it was clear from the appearance of the crops that the effect of the phosphates was very much more marked at three to ten weeks than at eleven months, when the effect is comparatively small.

This year we have results on crops under the same conditions at nine, and eighteen weeks old respectively.

It can be seen how very much greater is the influence of the phosphatic manure on the younger plants.

It is for this remarkable action on the early stages of their growth that phosphatic manures are so valuable in assisting to grow a good green crop quickly.

It may be noted that in these experiments the four phosphatic manures are again placed in the same order of efficiency.

BOGA MEDELOA (TEPHROSIA CANDIDA).

	Sown immediately after application of manure.		Sown 1 year after application of manure.			
	11 months old.		18 weeks old.		9 weeks old.	
	Wt. of crop in cwt. per acre.	Incr. per cent.	Wt. of crop in cwt. per acre.	Incr. per cent.	Wt. of crop in cwt. per acre.	Incr. per cent.
Limestone only	287 ...	−17	*a* 174 *b* 155 } 164	− 9	54	+8
Check plot. Limestone ... ... Sulphate of ammonia ... Sulphate of potash ...	344 ...	...	*a* 191 *b* 170 } 180½	...	50	...
Limestone ... ... Sulphate of ammonia ... Sulphate of potash ... EPHOS BASIC PHOSPHATE	352 ...	+ 3	*a* 184 *b* 172 } 178	...	64	+28
Limestone ... ... Sulphate of ammonia ... Sulphate of potash ... DEGELATINISED BONES	411 ...	+19	*a* 197 *b* 199 } 198	+10	71	+42.5
Limestone ... ... Sulphate of ammonia ... Sulphate of potash ... SUPERPHOSPHATE ..	441 ...	+28	*a* 210 *b* 201 } 205	+14	86	+72
Limestone ... ... Sulphate of ammonia .. Sulphate of potash ... BASIC SLAG	443 ...	+29	*a* 209 *b* 191 } 200	+11	90	+80

SOME OBSERVATIONS ON TEA SEEDLINGS

BY

A. C. TUNSTALL, B. SC.

During the present season many specimens of unhealthy seedlings have been received by this department. They came from all districts and there is reason to suppose that the year has been a very bad one for nurseries. In a few cases the ill-health could be definitely ascribed to a specific disease, but most of the specimens showed no indications of the attack of any vegetable or animal parasites, and the reason for their ill-health must be sought elsewhere.

These cases will be considered first. The majority of the specimens showed signs of injury at the collar and many had bent and twisted roots as well. A microscopic examination of the tissues of the collars revealed no fungus mycelium nor anything which would lead to the supposition that insects had caused the injury. The cortex and the growing layers had been destroyed. Sometimes the roots were damaged, sometimes the stems, and in many cases the injury was broad enough to include portions of both stems and roots. The position on the plants appeared to be determined by the depth of planting, the injury taking place just at the surface of the soil. There was nothing to prevent the upward flow of the solution derived from the soil, but the tissues, in which the organic food stuff, elaborated in the leaves from this solution and the carbonic acid gas from the air, are transported, were completely destroyed. The roots were therefore cut off from their supplies, for the solution derived from the soil is useless for the nourishment of the plant until it has been elaborated.

In order to remedy the damage the plants had produced swellings above the injured place and, in cases of slight damage, this may have succeeded in bridging the gap. If it had not done so new

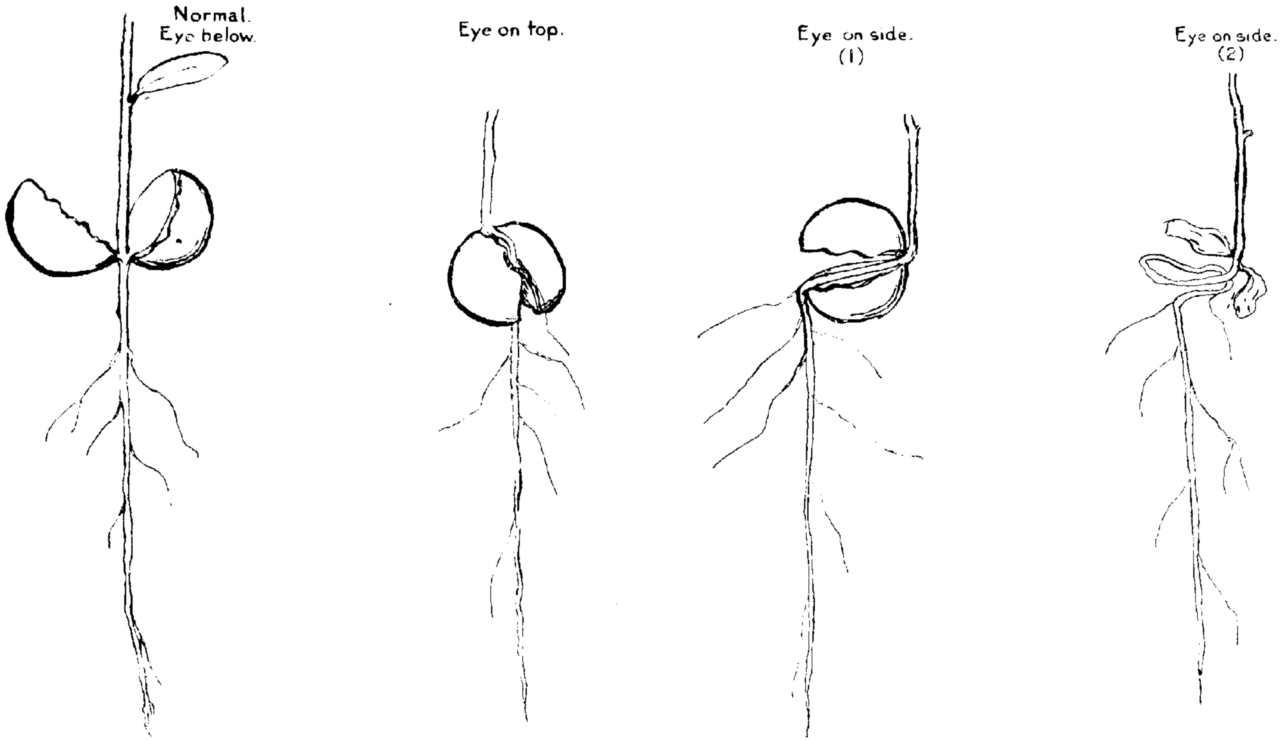
roots were in some cases produced at the swellings and the old roots died away. Even supposing the seedlings recovered they must of necessity have been severely checked, and will rarely produce satisfactory plants.

It would be best under the circumstances to discard all seedlings injured in this way, without any attempt at curing them. Prevention, therefore, is the only reasonable method of treatment of this disease. The injury is not due to any organic disease but appears to be physical.

A study has been made of the physical conditions under which this disease occurs. In most of the tea districts the weather early this year was abnormal, periods of exceptionally bright hot sunny weather alternated with those of heavy rain. The disease did not usually occur on shaded nurseries but was generally found only on those exposed to the sun. It would seem therefore that the sun had something to do with it. Moreover the disease was common only on sandy soils. No seedlings growing on clay soils were observed to be suffering from this disease. *Sandy soils get much hotter under the sun's rays than those containing much clay* and it would seem probable that the injury was due merely to the burning of the collars of the seedlings by the sun's rays. The long periods of wet weather which preceded the hot spells would weaken the seedlings and thus render them more liable to injury of this nature.

To prevent a recurrence of the disease, attention should be paid to the following points :

The seed beds should be very carefully drained and shaded and the shading should not be removed until after the hot dry weather which usually occurs in May. If for any reason it is considered advisable to remove the shading before this time a mulch of *dried* grass should be placed round each seedling. This mulch should be stirred up after rain so that it does not rot and thus form a harbouring place for diseases, which may prove more injurious than the damage to avoid which its use is recommended. It is frequently possible to prevent the death of slightly diseased seedlings by the application of a little cattle or other mildly


Normal.
Eye below.
Eye on top.
Eye on side.
(1)
Eye on side.
(2)

stimulating manure, but as mentioned above the resulting plants are never likely to develop into very satisfactory bushes.

Another point which deserves discussion is the large percentage of bent seedlings which are found in many nurseries. It is unnecessary to point out to a practical planter that a bent seedling is not likely to produce as good a bush as a straight one. It is well to prevent the bending of the seedlings if it be possible to do so economically.

Some time ago the scientists engaged in the investigation of tea in Java paid some attention to this question and the results of their observations were published in a bulletin.*

The seed of the tea plant is provided with a hard shell which splits on germination. The two cotyledons—the seed lobes, in which are stored the products on which the young plant feeds—open out so as not to hinder the development of the root and shoot. The shell splits along the line between the cotyledons commencing at the eye and following the seed lobes so that the seed separates almost symetrically. The rootlet, which develops first, is near the eye, and arranged in such a manner that it grows straight out through the eye. As the root grows directly downwards it would be logical to suppose that the most suitable position of the seed at the time of germination would be with the eye downwards.

This supposition was borne out by the Java experiments. Seed was planted in three ways :—

(1) with the eye above :
(2) with the eye at the side :
(3) with the eye beneath :

With the eye above or on one side the springing apart of the seed lobes takes place irregularly, and the rootlet, which is induced to grow downwards by geotropic stimulus, is sometimes hindered by the seed lobe or the shell, and may be bent on itself two or three times before it commences to grow straight down. Sometimes the root grows between the shell and the seed lobe and grows round and round until it finds an opening. It is readily understood

* Meded. van het Proefstation voor Thee. No. XLIII.—1.
Over de Keiming van de Theezaden. Dr. Ch. Bernard.

that the percentages of bent roots is high under these circumstances.

With the eye below the root commences to grow downwards at once and the cotyledons spring apart satisfactorily giving full play to the developing shoot, and the percentage of bent seedlings is negligible in this case.

It may be argued that, under the conditions which obtain on the average tea estate, it is impossible to ensure the planting of the seeds with the eye downwards. It was however found that it could be done as a practical measure in Java, and there is no reason, theoretical or practical, to suppose that it cannot be done in North-East India. The common practice at present is to germinate the seed in pits before planting it into nursery beds. This method is not very satisfactory from the point of view of bending, as the seed lies in all directions in the pit, and unless it be planted out just as soon as the rootlet appears outside the shell the bending will take place. As the seeds do not all germinate at the same time some of the roots will be bent before the bulk of the seed is ready for planting out.

Fortunately there are few diseases which seriously affect young tea plants which are due to vegetable parasites. The most common are Red Rust and Die-back. These diseases are to be found on all nurseries after periods of bad weather. Red Rust is too well known to need description, but Die-back, though just as prevalent, often escapes notice. The leaves become spotted with large brown patches and the ends of the branches die back, just as with Red Rust, but an examination of the dead portion shows no signs of Red Rust fructifications. It is however covered with black dots. These mark the fructifications of a species of *Gleosporium*. So far it has not been thought advisable to give this fungus a specific name, as it is almost certainly a stage of another fungus. Culture-experiments in our laboratory point to the conclusions that it is the same fungus which causes the ripe rot of many fruits. The remedy lies in cutting away the diseased shoots to clean healthy wood and spraying with a fungicidal mixture. It would be quite a good thing to spray all nurseries twice, once in March

and again in May, with a fungicide. Lime sulphur solution is suggested as very suitable. This would not cost very much and would save the plants from a good deal of damage. A species of *Rosellinia* kills a considerable number of plants in nurseries. It attacks the roots, and the seedlings die in patches. It is easily checked by watering the soil round the dead and dying seedlings with lime water and removing the dead ones.

Summary of suggestions :—

1. Special care should be taken on sandy soils, by shading or mulching, to prevent the sun from burning the collars of the plants.
2. Seed should be planted with the eye downwards.
3. Two applications of a fungicidal spray fluid should be made to nurseries, one about March and another in May.

ADDRESS TO DARJEELING PLANTERS.

Extract from the minutes of the proceedings of an Extraordinary General Meeting of the Darjeeling Planters' Association, held at the Club Premises, Darjeeling, on Saturday, the 29th July 1916, at 12 o'clock, the President, The Hon'ble Mr. H. R. Irwin, in the chair.

Mr. E. A. Andrews, Entomologist to the Indian Tea Association, delivered an address on Thrips, in which he described the results of the investigations on this insect carried out in the Darjeeling district during May last. The lecturer commenced by giving a brief account of the general characters of Thrips insects, and discussed the chief differences between the various families of Thrips. He then pointed out that the so-called "Common" and "Black" Thrips of tea are not in the same family, and might therefore be expected to show slight differences in behaviour which would necessitate a different treatment for each. This had been found to be the case in some respects. The chief differences lay in the behaviour of the insect at the pupal stage, and the number of generations in the year. In the case of the Common Thrips the larva descended into the soil to pupate, while the available evidence went to show that there are at most two generations in the year. In the case of the Black Thrips, the pupa was to be found in the mosses and lichens on the stems of the bushes, while the available evidence led one to believe that there are at least two generations in the year, probably more. The egg, the manner of oviposition, and the larval, pre-pupal, pupal, and adult stages of the Common Thrips were described. The egg of the Black Thrips could not yet be described, but the larval, pupal, and adult stages are now known, and brief descriptions of them were given. The Black Thrips found in roses in Darjeeling is not the same as the Black Thrips of tea, as some formerly supposed, but is a different species, belonging to the same family as the Common Thrips.

The lecturer then proceeded to discuss the question of control. The eggs are laid in the leaf tissue of the pekoe leaves and buds, and any eggs in a mature shoot at the time of plucking are thus removed by the pluckers. The operation of plucking therefore had a small effect in reducing the numbers of the insects. This fact, however, was not in itself a justification for hard plucking directly the Thrips appeared. During the opening stages of an attack the insects are in process of emerging from the soil. Plucking off affected shoots might remove the insects then on the bush, but would not affect those still in the soil, and would, in addition, cause a greater proportion of buds to be attacked, and attack on the buds was more serious than on the well-developed shoots. During the later stages of the attack, however, when all of the last year's brood had emerged from the soil, plucking of all affected shoots might be carried out with advantage.

China bushes suffer more severely, as a rule, than indigenous bushes, and strongly flushing tea suffers less than weak tea giving slow growth. In the plains, where bushes flush more vigorously, Thrips does very little harm, although found to occur there occasionally. Another method of dealing with the pest would therefore seem to be the use of suitable forcing manures, so far as this could be done without affecting quality adversely, combined with the use of soil correctives where necessary.

Cultivation was another garden operation which should receive attention in dealing with Thrips. It had been found that the Common Thrips descended to the soil to pupate, and that it required fairly firm soil in which to do so. In places where cultivation was poor it was found only four or five inches below the surface, but where trenching had been carried out it was found at a depth of one foot. The larva became a pre-pupa in twenty-four hours, and had turned into a pupa in a further twenty-four hours, thus changing from an active to a passive organism in two days. Any operation, such as trenching and deep forking round the bushes, which loosened the soil for some distance down, diminished the insect's chances of reaching a suitable environment before he became sufficiently inactive to make no further progress.

The lecturer was of opinion, after considering all sides of the question, that the presence or absence of shade trees as usually planted did not exercise a great deal of influence on the distribution of the insects, though very heavy shade, such as that given by close-planted Fullidhas, might have a slight deterrent effect.

Experiments with insecticides had shown that these substances could be used with success against Thrips. Crude Oil Emulsion, Lime-Sulphur Solution, "Cook's Nicotine Spray," "Katakilla," and "Insecticide—XEX Green," had all been used with benefit, the most effective being the last-named, which besides giving an increase of 78% in the weight of leaf obtained, had produced a marked reduction in the percentage of shoots attacked, as, whilst on the untreated plots 50% of the shoots were attacked, only 5% of the shoots obtained from the plot treated with this substance showed any sign of damage.

In the case of the Black Thrips, the pupa was found to occur in the mosses and lichens on the stems of the bushes. Steps should therefore be taken to remove these, and for this purpose the application of soda-ash, in the cold weather, which had already given good results in the Darjeeling district, was recommended.

NOTES.

The source of nitrogen in leguminous plants*.—Valuable information is contained in Bulletin No. 179, issued by the University of Illinois Agricultural Experiment Station, dealing with the subject of a biochemical study of nitrogen in certain legumes. For Experiment Station workers the method described will be found very useful and valuable, while the general reader concerned with leguminous crops will find the conclusions drawn from these experiments especially interesting. It is shown conclusively that the Cowpeas and Soy beans utilize atmospheric nitrogen through their roots and not through their leaves. No combined nitrogen could have been assimilated in the gas experiments conducted. The total nitrogen determination shows that about 74 per cent. of the nitrogen of Cowpeas and Soy beans at the time of harvest is in the tops, while the remainder is distributed between the roots and the nodules. In the earlier periods, the roots contain a large proportion, while later they contain a much smaller proportion. It appears that there is a larger percentage of soluble nitrogen in the tops than in the roots or in the nodules. It is stated further that fixation takes place at a very early period in the growth of the seedling—sometimes within fourteen days. It is rapid in some cases, especially with Cowpeas. Plants grown under the conditions of the experiments described in the Bulletin contain no ammonia, nitrites, or nitrates, as measured by the most accurate chemical methods.

Lime-sulphur paint.—The following Lime-sulphur paint has been used with marked success against scale-insects on the stems of trees in the West Indies :—

Sulphur	2 lbs.
Unslaked lime	1 lb.
and Water	2 gallons

* Reprinted from the Agricultural News (West Indies) June 17th, 1916.

are boiled for an hour and a half ; 3 lbs. more lime is then added and the mixture boiled again for half an hour, and afterwards made to 2 gallons once more. Flour or fine clay is then added to the mixture until it is of the consistency of thin paint, when it can be applied to the stems of the trees with a brush. This paint not only kills the scales, but has a very cleansing effect on the trees.

Borax for Wire-worms.—A Norwegian entomologist has recently found that a 1 % solution of borax, poured on to the soil, is very effective against wire-worms.

Green manuring.—In connection with the article on Green Manures in the last issue of the Quarterly Journal, Part II of 1916, an enquiry has reached us regarding our statement that, when green manures have been buried, frequent cultivation afterwards will increase the effectiveness of the action of the crop on the tea. In the enquiry alluded to it is suggested that when green manures have been buried in trenches, since cultivation cannot reach the bottom of trenches the total effect of the green crop, instead of being beneficial, may be positively harmful owing to the production of toxins in the soil, which remain there as cultivation does not reach that depth.

The following is the substance of the reply in which we answered the question :—

The article the enquirer referred to has given him we think an exaggerated idea of the possibility of harm from the use of green manures. When green crops are growing positive damage to tea is only to be feared from two causes :

(1) excessive temporary removal of moisture from the soil, if the manure is grown in a dry year or at a dry time of year :

(2) formation of poisonous substances which may temporarily inhibit the growth of the tea bushes if the green matter is buried in a water-logged soil.

The recommendation to stir up soils after burial of green manures is made in ordinary circumstances rather with the intention

of promoting increase in the benefit done by green manuring than to obviate possible harm.

The article in question seeks to explain that it is only when they have undergone the proper decomposition that green manures become useful, and that this decomposition takes place in two stages for which :—

(1) the presence of much water is necessary.

(2) the presence of air is necessary.

The first stage in the decomposition can proceed without the presence of air, and in fact goes on best if no air, but much water is present. During this stage of the decomposition, substances poisonous to plants are produced.

In the second stage air is necessary to convert the nitrogen compounds into useful nitrates, and also to oxidise the toxins produced in the first stage, and so render them not only harmless, but beneficial. If green manure is buried in a water-logged soil, the decomposition stops at the first stage, and the total effect of the green manure will be bad unless dry weather quickly sets in so as to allow the entry of some air into the soil.

On normal, wet—but not water-logged—soils, sufficient air is present to allow of the destruction of the poisons soon after they are formed. This process will be hastened and the efficiency of the green manuring increased by cultivation.

Trenching is done in the cold weather ; at this season there is plenty of air in soil at eighteen inches or whatever may be the depth of the trenches. None of the harmful effects of water-logging are then to be feared.

In the cold weather and the spring it is far better to get the manure in deep, because unless sufficient water is present the decomposition of the manure is very slow.

At the usual time for trenching, there is sufficient moisture and air at the bottom of a trench to effect the necessary decompositions satisfactorily, and no harm need be feared.

The price of manures.—The following tables have been worked out from quotations for manures of various kinds :—

(*a*) in England just before the outbreak of war
(*b*) in England in May of this year
(*c*) in Calcutta early in 1914, and
(*d*) in Calcutta in August of this year.

They afford an interesting comparison of the normal price of manures in England with those quoted at Calcutta, and of the effect of the war on both these markets. The full reasons for the variations in the price of each of the individual manures could only be explained by one well-acquainted with the conditions of their manufacture and shipment in different parts of the world and one knowing also how their production is affected by the movements of other markets. The war of course has affected the manure industries enormously.

The reasons for some of the bigger fluctuations are apparent. Potash for instance is not quoted in Table B because practically all the potash manures normally consumed in England come from Germany, and their importation has ceased. Again sulphate of ammonia and nitrate of potash are produced in India, and the reason for the rise in price of the former is not quite clear, though it is probably in sympathy with the fluctuations on the Home markets. The use of nitrate of potash on tea estates as a source of potash has been introduced partly as the result of shipment of potash manures from Germany having ceased, and partly because higher prices are ruling generally which brings this manure into line, in the matter of price, with other nitrogenous manures. Nitrate of soda will not have an extended sale for use on tea estates until its exorbitantly high price is lowered. At the present moment oilcakes, dried blood, sterilized animal meal, and various forms of bones give the best value for money. The shipment of bones from India to Europe has become considerably restricted owing to the war. Superphosphate is dear but not so dear relatively as basic slag, which is at an entirely prohibitive price. Nitrolim (calcium cyanamide) is also very dear at present.

These considerations should weigh when manurial programmes are being decided.

TABLE A.—*The following are prices of manures per ton, and value per unit of Nitrogen Phosphoric acid and Potash in these manures which obtained in England just before the outbreak of war.*

	MANURES.	Percentage composition. N.	Percentage composition. P_2O_5	Percentage composition. K_2O	Price per ton. Rs.	As.	P.	Unit value. N. Rs.	A.	P.	Unit value. P_2O_5 Rs.	A.	P.	Unit value. K_2O Rs.	A.	P.	Remarks.
1.	Nitrate of Soda ...	15	...	...	172	8	0	11	8	0	...	...	...	...	...	...	
2.	Sulphate of ammonia ...	20	...	...	187	8	0	9	6	0	...	...	...	...	...	...	
4.	Dried blood ...	12	...	...	180	0	0	15	0	0	...	...	...	...	...	...	
6.	Superphosphate ...	...	13·73	...	41	0	0	...	...	...	3	0	0	...	...	...	
7.	Basic slag	[illegible]	10·98—19·22 (9·15—15·56 soluble.)	...	20 to 39	4 0	0 0	...	...	...	2	5	1	...	...	...	
9.	Sulphate of potash ...	...	...	48·5	170	10	0	...	...	...	...	...	...	3	8	0	
11.	Rape cake	4·75	1·83	...	90	0	0	18	0	0	...	...	...	...	...	...	Allowing Rs. 2-7-3 per unit of P_2O_5.
12.	Fish	9	3·66	...	136	14	0	14	0	8	...	...	...	...	...	...	" " 2-13-9 " " "
13.	Meat	6·5	7·78	...	112	8	0	13	14	0	...	...	...	...	...	...	" " 2-13-9 " " "
15.	Peruvian guano ...	6	13·73	2	153	12	0	17	15	0	...	...	...	...	...	...	" " 2-13-9 " " " and Rs. 3-6-0 per unit of K_2O.

Manures.	Percentage composition. N.	P_2O_5	K_2O	Price per ton. Rs.	As.	P.	Unit value. N. Rs.	A.	P.	P_2O_5 Rs.	A.	P.	K_2O Rs.	A.	P.	At	Remarks.
1. Nitrate of soda 95 per cent....	15·6	...	...	262	2	0	17	3	0	...	...	...	...	...	...	Bristol	
" " 90 " ...	14·8	...	...	261	5	0	17	10	6	...	...	...	...	...	...	London	
2. Sulphate of ammonia ...	20·1	...	...	249	3	7	12	4	0	...	...	...	...	...	...	London	
" " ...	19·7	..	...	256	1	7	13	0	0	..	...	...	...	...	...	Bristol	
3. Nitrolim (calcium cyanamide)	...	...	...	......			13	8	0	...	...	...	...	...	...	London	
5. Castor meal	...	...	...	......			15	11	6	...	...	...	...	...	...	Hull	
6. Superphosphate ...	...	16·02	...	71	5	5	...	...	...	4	7	3	...	...	...	London	
"	...	15·10	...	66	15	3	...	...	...	4	7	0	...	...	...	London	
"	...	13·73	...	61	12	6	...	...	...	4	8	0	...	...	...	London	
"	...	11·89	...	59	4	2	...	...	...	4	15	9	...	...	...	London	
7. Basic Slag :—																	
Insoluble phosphoric acid (citric acid soluble) in basic slag	...	...	...	......			...	...	...	4	2	8	...	...	...	London	
Insoluble phosphoric acid in basic slag	...	...	...	......			...	...	...	3	1	1	...	...	...	Hull	
12. Fish guano :—																	
Insoluble phosphoric acid in fish guano	...	...	...	......			...	...	...	4	7	0	...	...	...	London	Allowing Rs. 17-13-6 for N.
14. Bones :—																	
Soluble phosphoric acid in dissolved bones ...	...	...	...	......			...	...	...	6	3	6	...	...	...	London	" " 15-4-6 " and Rs. 3-13-1 for insoluble phosphoric acid.
Insoluble phosphoric acid in bone meal	...	...	...	......			...	...	...	3	5	7	...	...	...	London	Allowing Rs. 13-6-6 for N.
Insoluble phosphoric acid in steamed bone flour ...	...	...	...	......			...	...	...	3	5	7	...	...	...	London	" " 13-7-6 "

TABLE C.—*The following are prices of manures per ton, and value per unit of Nitrogen Phosphoric acid and Potash in these manures which obtained in Calcutta in May 1914.*

MANURES.	Percentage composition.			Price per ton.			Unit value.									Remarks.
	N	P_2O_5	K_2O				N.			P_2O_5			K_2O			
				Rs.	As.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	
1. Nitrate of soda ...	15	...	...	220	0	0	14	10	8	...	...	...	...	...	...	
2. Sulphate of ammonia ...	20	...	...	240	0	0	12	0	0	...	...	...	...	...	...	
3. Nitrolim (calcium cyanamide)	18	...	...	205	0	0	11	6	2	...	...	...	...	...	...	
4. Blood meal	12	...	...	200	0	0	16	10	8	...	...	...	...	...	...	
6. Superphosphate ...	...	18/20	...	75	0	0	...	...	...	3	15	2	...	...	...	
Ditto concentrated	...	42/45	...	165	0	0	...	...	...	3	12	8	...	...	...	
7. Basic slag	...	16	...	62	0	0	...	...	...	3	14	0	...	...	...	
8. Phosphate of lime ...	...	38	...	140	0	0	...	...	...	3	10	11	...	...	...	
9. Sulphate of potash ...	...	...	50	200	0	0	...	...	...	...	...	...	4	0	0	
10. Muriate of potash ...	...	...	50	170	0	0	...	...	...	...	...	...	3	6	4	
12. Milled fish guano ...	7	9	...	140	0	0	15	4	3	...	...	...	...	...	...	Allowing Rs. 3-10-11 per unit of P_2O_5
13. Sterilized animal meal ...	7·5	7·5	...	135	0	0	14	5	1	...	...	...	...	...	...	,, ,, 3-10-11 ,, ,,
14. Steamed bone meal ...	4	23	...	100	0	0	...	...	...	2	4	2	...	...	...	,, ,, 12-0-0 ,, N.

TABLE D.—*The following are prices of manures per ton, and value per unit of Nitrogen Phosphoric acid and Potash i these manures which obtained in Calcutta in August 1916.*

	MANURES.	PERCENTAGE COMPOSITION.			Price per ton.			UNIT VALUE.									REMARKS.
		N	P_2O_5	K_2O				N			P_2O_5			K_2O			
					Rs.	As.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	
1.	Nitrate of soda ...	15/16	...	...	320	0	0	20	10	3	...	...	...	...	...	...	
	,, potash ...	10	...	33	270	0	0	...	...	...	...	...	...	4 3	8 10	8 2	Allowing Rs. 12 per unit of N. ,, ,, 15 ,, ,,
2.	Sulphate of ammonia ...	20/21	...	...	310	0	0	15	1	11	...	...	...	...	...	...	
3.	Nitrolim	18	...	...	320	0	0	17	11	2	...	...	...	...	...	...	
4.	Dried blood	10	...	...	120	0	0	12	0	0	...	...	...	...	...	...	
5.	Castor oil cake ...	5	...	...	69	2	0	13	13	0	...	...	...	...	...	...	
6.	Superphosphate ...	...	21	...	105	0	0	...	...	...	5	0	0	...	...	...	
7.	Basic slag	...	10/11	...	90	0	0	...	...	...	9	0	0	...	...	...	
8.	Phosphate of lime ...	...	11/12	...	100	0	0	...	...	...	8	5	3	...	...	...	
9.	Sulphate of potash ...	...	...	25	200	0	0	...	...	...	...	...	...	8	0	0	
12.	Milled fish guano ...	7	9	...	165	0	0	...	...	...	9 6	0 10	0 8	...	...	...	Allowing Rs. 12 per unit of N. ,, ,, 15 ,, ,,
	Sardine guano ...	5/7	10/12	...	140	0	0	...	...	...	6 4	2 8	10 8	...	...	...	,, ,, 12 ,, ,, ,, ,, 15 ,, ,,
13.	Sterilized animal meal ...	7·5	7·6	...	135	0	0	14	5	1	...	...	...	...	...	...	,, ,, 3-10-0 per unit of P_2O_5
14.	BONES :—																
	A { Steamed bones ...	4·25	22	...	68	0	0	...	...	...	0	12	4	...	...	...	,, ,, 12 per unit of N.
	A { Unsteamed bones ...	4·5	22	...	62	0	0	...	...	...	0	5	9	...	...	...	,, ,, 12 ,, ,,
	B { Steamed bones ...	3·5	22/23	...	75	0	0	...	...	...	1	8	0	...	...	...	,, ,, 12 ,, ,,
	B { Unsteamed bones ...	3·5	22/23	...	70	0	0	.	...	...	1	4	4	...	...	...	,, ,, 12 ,, ,,

C. O. P.—1100—30-10-1916.